

CLAIMS

1. A three-dimensional pointing method for pointing at a desired point in a three-dimensional space represented on a display apparatus based on two-dimensional coordinates of a position that is pointed at by a pen tip of an input pen on a predetermined detection plane and based on pen pressure that is pressure applied to the pen tip of the input pen, comprising the step of:

changing a depth direction coordinate of a three-dimensional pointer to be displayed in the three-dimensional space according to the pen pressure of the input pen, and displaying the three-dimensional pointer.

2. A three-dimensional pointing method for pointing at a desired point in a three-dimensional space represented on the display apparatus based on two-dimensional coordinates of a position that is pointed at by a pen tip of an input pen on a predetermined detection plane, pen pressure that is pressure applied to the pen tip of the input pen, an inclination angle that is an angle between an axis of the input pen and the detection plane, and an direction angle that is an angle between a projection of the axis of the input pen onto the detection plane and a predetermined line on the detection plane, comprising the steps of:

obtaining an extension of the axis of the input pen in the three-dimensional space based on the inclination angle and the direction angle of the input pen;

displaying a three-dimensional pointer on

the extension in the three-dimensional space; and  
changing a coordinate of a three-  
dimensional pointer in the direction of the  
extension in the three-dimensional space according  
5 to the pen pressure of the input pen, and displaying  
the three-dimensional pointer.

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3. A three-dimensional pointing method for  
pointing at a desired point in a three-dimensional  
space represented on the display apparatus based on  
two-dimensional coordinates of a position that is  
15 pointed at by a pen tip of an input pen on a  
predetermined detection plane, and based on time for  
continuing to point or operation of an operation  
means provided in the input pen, comprising the step  
of:

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changing a depth direction coordinate of a  
three-dimensional pointer to be displayed in the  
three-dimensional space according to the time for  
continuing to point with the pen tip of the input  
pen or the operation of the operation means of the  
25 input pen, and displaying the three-dimensional  
pointer.

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4. A three-dimensional pointing method for  
pointing at a desired point in a three-dimensional  
space represented on the display apparatus based on  
two-dimensional coordinates of a position that is  
35 pointed at by a pen tip of an input pen on a  
predetermined detection plane, time for continuing  
to point or operation of an operation means provided

in the input pen, an inclination angle that is an angle between an axis of the input pen and the detection plane, and a direction angle that is an angle between a projection of the axis of the input pen onto the detection plane and a predetermined line on the detection plane, comprising the steps of:

obtaining an extension of the axis of the input pen in the three-dimensional space based on the inclination angle and the direction angle of the input pen;

displaying a three-dimensional pointer on the extension in the three-dimensional space; and changing a coordinate of a three-dimensional pointer in the direction of the extension in the three-dimensional space according to the time for continuing to point with the pen tip of the input pen or according to the operation of the operation means of the input pen, and displaying the three-dimensional pointer.

5. The three-dimensional pointing method as claimed in any one of claims 1-4, wherein it is determined that an object is pointed at when the object exists within a predetermined distance from three-dimensional coordinates of a point at which the three-dimensional pointer points.

6. The three-dimensional pointing method as claimed in any one of claims 1-4, wherein, when an object displayed in the three-dimensional space

is pointed at with the three-dimensional pointer, if operation for selecting or holding the object is performed,

5 the three-dimensional position of the object is changed according to change of the three-dimensional position of the three-dimensional pointer after the operation for selecting or holding the object is performed, and the object is displayed.

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7. The three-dimensional pointing method as claimed in any one of claims 1-4, wherein, when  
15 an object displayed in the three-dimensional space is pointed at with the three-dimensional pointer, if operation for starting to operate, edit or process the object is performed,

20 the object that is pointed at is displayed two-dimensionally on a plane, of the display apparatus, that is closest to an operator, and

the two-dimensionally displayed object accepts the two-dimensional operation, editing, or processing by the input pen.

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8. The three-dimensional pointing method  
30 as claimed in any one of claims 1-3, wherein the two-dimensional coordinates of the position at which the pen tip of the input pen points on the detection plane is regarded as two-dimensional coordinates of the point at which the three-dimensional pointer  
35 points, and the depth direction coordinate of the three-dimensional pointer is changed while keeping the two-dimensional coordinates of the point at

which the three-dimensional pointer points to be constant.

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9. A three-dimensional pointing apparatus for generating a pointer based on two-dimensional coordinates of a position that is pointed at by a  
10 pen tip of an input pen on a predetermined detection plane and based on pen pressure that is pressure applied to the pen tip of the input pen, and displaying the generated pointer at a desired point in three-dimensional space represented on a display  
15 apparatus to perform pointing, comprising:

input information obtaining means for obtaining information of the two-dimensional coordinates and the pen pressure of the input pen;

pointer position/rotation angle  
20 calculation means for calculating a position and an rotation angle of the pointer to be displayed in the three-dimensional space represented on the display apparatus based on the information obtained by the input information obtaining means;

25 pointer generation means for generate the pointer based on the calculation result of the pointer position/rotation angle calculation means;

pointing determination means for determining whether there is an object that is  
30 pointed at by the pointer generated by the pointer generation means in the three-dimensional space represented on the display apparatus;

object generation means for generating the object to be displayed in the three-dimensional  
35 space represented on the display apparatus; and

display control means for displaying the pointer generated by the pointer generation means

and the object generated by the object generation means in the three-dimensional space represented on the display apparatus,

5                   wherein the pointer position/rotation angle calculation means changes a depth direction coordinate of the three-dimensional pointer to be displayed in the three-dimensional space according to the pen pressure of the input pen in the calculation.

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10. A three-dimensional pointing apparatus  
15   for generating a pointer based on two-dimensional coordinates of a position that is pointed at by a pen tip of an input pen on a predetermined detection plane and based on time for continuing to point or operation of an operation means provided in the  
20   input pen, and displaying the pointer at a desired point in a three-dimensional space represented on a display apparatus to perform pointing, comprising:

                  input information obtaining means for obtaining information of the two-dimensional  
25   coordinates of the input pen, and information of contact/noncontact status of the pen tip of the input pen or information of operation of an operation means of the input pen;

                  input information process means for  
30   calculating the time for continuing to point with the pen tip of the input pen or an amount by which the operation means is operated based on the information obtained by the input information obtaining means;

35                   pointer position/rotation angle calculation means for calculating a position of the pointer to be displayed in the three-dimensional

space represented on the display apparatus based on the information obtained by the input information obtaining means;

5 pointer generation means for generating the pointer based on the calculation result of the pointer position/rotation angle calculation means;

pointing determination means for determining whether there is an object that is pointed at by the pointer generated by the pointer generation means in the three-dimensional space represented on the display apparatus;

object generation means for generating the object to be displayed in the three-dimensional space represented on the display apparatus; and

15 display control means for displaying the pointer generated by the pointer generation means and the object generated by the object generation means in the three-dimensional space represented on the display apparatus,

20 wherein the pointer position/rotation angle calculation means performs the calculation by changing a depth direction coordinate of the three-dimensional pointer to be displayed in the three-dimensional space according to the time for  
25 continuing to point or according to the operation of the operation means provided in the input pen.

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11. The three-dimensional pointing apparatus as claimed in claim 10, wherein the pointing determination means determines that an object is pointed at when the object exists within a  
35 predetermined distance from three-dimensional coordinates of a point at which the three-dimensional pointer points.

5                   12. The three-dimensional pointing  
apparatus as claimed in claim 9 or 10, wherein the  
object generation means comprising means for  
changing the three-dimensional position of the  
object according to change of the three-dimensional  
10 position of the three-dimensional pointer to  
generate the object, and  
when an object displayed in the three-  
dimensional space is pointed at with the three-  
dimensional pointer, if operation for selecting or  
15 holding the object is performed,  
the three-dimensional position of the  
object is changed according to change of the three-  
dimensional position of the three-dimensional  
pointer after the operation for selecting or holding  
20 the object is performed, and the object is displayed.

25                   13. The three-dimensional pointing  
apparatus as claimed in claim 9, wherein, in  
addition to the information of the two-dimensional  
coordinates and the pen pressure, the input  
information obtaining means obtains an inclination  
30 angle that is an angle between an axis of the pen  
and the detection plane, and an direction angle that  
is an angle between a projection of the axis of the  
input pen onto the detection plane and a  
predetermined line on the detection plane, and  
35 the pointer position/rotation angle  
calculation means obtains an extension of the axis  
of the input pen in the three-dimensional space



based on the inclination angle and the direction  
angle of the input pen, sets a position of a three-  
dimensional pointer to be on the extension in the  
three-dimensional space, and performs the  
5 calculation by changing a coordinate of the three-  
dimensional pointer in the direction of the  
extension in the three-dimensional space according  
to the pen pressure of the input pen.

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14. The three-dimensional pointing  
apparatus as claimed in claim 10, wherein, the input  
15 information obtaining means obtains information of  
an inclination angle that is an angle between an  
axis of the pen and the detection plane, and  
information of a direction angle that is an angle  
between a projection of the axis of the input pen  
20 onto the detection plane and a predetermined line on  
the detection plane, and

the pointer position/rotation angle  
calculation means obtains an extension of the axis  
of the input pen in the three-dimensional space  
25 based on the inclination angle and the direction  
angle of the input pen, sets a position of a three-  
dimensional pointer to be on the extension in the  
three-dimensional space, and performs the  
calculation by changing a coordinate of the three-  
30 dimensional pointer in the direction of the  
extension in the three-dimensional space according  
to the time for continuing to point or the operation  
of the operation means provided in the input pen.

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15. The three-dimensional pointing apparatus as claimed in claim 8 or 10, wherein the input information obtaining means further obtains information of a rotation angle of the input pen  
5 that is a rotation angle around the axis of the input pen when pointing with the pen tip of the input pen is performed on the detection plane, and the pointer position/rotation angle calculation means performs the calculation by  
10 changing a rotation angle around the axis of the three-dimensional pointer according to the rotation angle of the input pen.

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16. The three-dimensional pointing apparatus as claimed in claim 9 or 10, the object generation means comprising means for, when an  
20 object displayed in the three-dimensional space is pointed at, if operation for starting to operate, edit or process the object is performed, generating an object that is a projection of the pointed object at onto a plane, of the display apparatus, that is  
25 closest to an operator.

30 17. The three-dimensional pointing apparatus as claimed in claim 16, wherein, after the object two-dimensionally displayed on the closest plane accepts the two-dimensional operation, editing, or processing with the input pen, when operation for  
35 ending the operation, editing, or processing for the object is performed, the object generation means generates an object obtained by restoring the two-

dimensionally displayed object to a three-  
dimensionally display state just before the  
operation for starting the operation, editing or  
processing is performed.

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18. The three-dimensional pointing  
10 apparatus as claimed in claim 9, wherein the input  
pen has a structure in which the length of the pen  
tip is shortened according to the pen pressure, and  
the three-dimensional pointer has a shape  
similar to the pen tip of the input pen, or a shape  
15 similar to a part of the pen tip.

20 19. The three-dimensional pointing  
apparatus as claimed in claim 10, wherein the input  
pen has a structure in which the length of the pen  
tip is shortened according to the time for  
continuing to point with the pen tip or according to  
25 the operation of the operation means, and  
the three-dimensional pointer has a shape  
similar to the pen tip of the input pen, or a shape  
similar to a part of the pen tip.

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20. The three-dimensional pointing  
apparatus as claimed in claim 9 or 10, wherein the  
35 pointer position/rotation angle calculation means  
sets the two-dimensional coordinates of the point at  
which the three-dimensional pointer points to be the

two-dimensional coordinates of the position at which the pen tip of the input pen points on the detection plane, and changes the depth direction coordinate of the three-dimensional pointer while keeping the two-dimensional coordinates of the point at which the three-dimensional pointer points to be constant.

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21. A three-dimensional pointing program for causing a computer to execute processes in each means of the three-dimensional pointing apparatus as claimed in any one of claims 9-20.

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22. A three-dimensional pointing method for moving a pointer, in a three-dimensional space, that is displayed in the three-dimensional space of a display apparatus that can represent the three-dimensional space, and pointing at a desired point in the three-dimensional space, comprising:

25 a step 1 of moving or rotating the pointer on a two-dimensional plane that is perpendicular to a depth direction of the three-dimensional space of the display apparatus, and moving the pointer in the depth direction;

30 a step 2 of moving a part for performing pointing in the pointer in the depth direction while keeping, to be constant, a depth direction position of a predetermined point of the pointer other than the part for performing pointing in the pointer, and  
35 while keeping a shape and a size of the pointer to be constant, wherein the part for performing pointing in the pointer includes a point for

performing pointing and the neighborhood; and  
a step 3 for causing the display apparatus  
to display the pointer moved in the step 1 and the  
step 2.

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23. The three-dimensional pointing method  
as claimed in claim 22, wherein, in step 2, the  
pointer is rotated around a predetermined center  
point or center axis, wherein points on the surface  
or the inside of the pointer are excluded for the  
predetermined center point or the center axis.

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24. A three-dimensional pointing method  
for moving a pointer, in a three-dimensional space,  
that is displayed in the three-dimensional space of  
a display apparatus that can represent the three-  
dimensional space, and pointing at a desired point  
in the three-dimensional space, comprising:

a step 1 of moving or rotating the pointer  
on a two-dimensional plane that is perpendicular to  
a depth direction of the three-dimensional space of  
the display apparatus, and moving the pointer in the  
depth direction;

a step 4 of moving a part for performing  
pointing in the pointer in the depth direction while  
keeping a depth direction position of a  
predetermined point of the pointer other than the  
part for performing pointing in the pointer to be  
constant, and while deforming a shape and a size of  
the pointer; and

a step 3 for causing the display apparatus

to display the pointer moved in the step 1 and the step 4.

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25. The three-dimensional pointing method as claimed in claim 24, wherein, in step 4, the pointer is rotated around a predetermined center point or center axis, wherein points on the surface or the inside of the pointer are excluded for the predetermined center point or the center axis.

15

26. The three-dimensional pointing method as claimed in claim 23 or 25, wherein the center point or the center axis around which the pointer is rotated moves according to a rotation angle when the pointer rotates.

25

27. The three-dimensional pointing method as claimed in claim 24, the pointer comprising:  
a first part in which the depth direction position, a position on the two-dimensional plane, the shape and the size are constant;  
a second part in which at least the depth direction position changes; and  
a third part for connecting the first part with the second part,  
wherein, in the step 4, the second part of the pointer is moved in the depth direction.

28. The three-dimensional pointing method  
5 as claimed in claim 27, wherein, in the step 4, the  
second part is moved in the depth direction while  
changing the position of the second part in the two-  
dimensional plane, or a shape of the second part, or  
10 a size of the second part of the three-dimensional  
pointer.

29. The three-dimensional pointing method  
15 as claimed in any one of claims 22-28, wherein, when  
a part of the pointer lies off the three-dimensional  
space that can be represented by the display  
apparatus when the pointer moves in the depth  
20 direction, the lain-off part is projected onto a  
two-dimensional plane, of two-dimensional planes  
that can be represented by the display apparatus,  
that is close to the lain-off part, or the lain-off  
part is bent, so as to display the part.

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30. The three-dimensional pointing method  
30 as claimed in any one of claims 22-28, wherein, in  
step 3, the display apparatus is caused to display a  
reference pointer, with the pointer, in which the  
depth direction position is constant.

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31. A three-dimensional pointing apparatus for displaying a pointer in a three-dimensional space represented on a display apparatus that can represent the three-dimensional space, moving the pointer three-dimensionally based on input information from an input apparatus, and pointing at an arbitrary point in the three-dimensional space, comprising:

input information obtaining means for obtaining input information from the input apparatus;

pointer position/deformation amount calculation means for calculating a display position and a deformation amount of the pointer based on the input information obtained by the input information obtaining means;

pointer generation means for generating a pointer to be displayed at the display position calculated by the pointer position/deformation amount calculation means;

pointing determination means for determining whether there is an object at a point at which the pointer points based on the display position calculated by the pointer position/deformation amount calculation means;

object generation means for changing the object to a state indicating that the object is pointed at when it is determined that there is the object that is pointed at in the pointing determination means; and

display control means for causing the display apparatus to display the pointer generated by the pointer generation means and the object generated by the object generation means.



32. The three-dimensional pointing apparatus as claimed in claim 31, the pointer generation means comprising means for moving a part  
5 for performing pointing in the pointer in the depth direction while keeping a depth direction position of a predetermined position of the pointer other than the part for performing pointing in the pointer, to be constant, and while keeping a shape and a size  
10 of the pointer to be constant, wherein the part for performing pointing includes a point for performing pointing and the neighborhood.

15

33. The three-dimensional pointing apparatus as claimed in claim 31, the pointer generation means comprising means for moving a part  
20 for performing pointing in the pointer in the depth direction while keeping a depth direction position of a predetermined position of the pointer other than the part for performing pointing in the pointer to be constant, and while deforming a shape and a  
25 size of the pointer.

30 34. The three-dimensional pointing apparatus as claimed in claim 32 or 33, wherein the means for moving the part for performing pointing in the pointer in the depth direction rotates the pointer around a predetermined center point or  
35 center axis, wherein points on the surface or the inside of the pointer are excluded for the predetermined center point or the center axis.

5                   35. The three-dimensional pointing  
apparatus as claimed in claim 31, the pointer  
generation means comprising:

                  means for dividing the pointer into a  
first part in which the depth direction position, a  
10 position on the two-dimensional plane, the shape and  
the size are constant, and a second part in which at  
least the depth direction position changes, and for  
moving only the second part in the depth direction;  
and

15                   means for connecting the first part with  
the second part after moving the second part in the  
depth direction.

20

                  36. The three-dimensional pointing  
apparatus as claimed in any one of claims 31-35, the  
pointer generation means comprising:

25                   means for determining whether a part of  
the pointer lies off the three-dimensional space  
that can be represented by the display apparatus  
when the pointer moves in the depth direction; and

                  means for, when there is the lain-off part,  
30 projecting the lain-off part onto a two-dimensional  
plane, of two-dimensional planes that can be  
represented by the display apparatus, that is close  
to the lain-off part, or bending the lain-off part.

35

37. A three-dimensional pointing program for causing a computer to execute processes in each means of the three-dimensional pointing apparatus as claimed in any one of claims 31-36.

5

38. A three-dimensional display control method for controlling display states of a pointer and one or more objects, when displaying the pointer and one or more objects in a three-dimensional space represented on a display apparatus that can represented the three-dimensional space, moving the pointer three-dimensionally based on input information from an input apparatus, and pointing at an arbitrary point in the three-dimensional space, comprising:

a step 1 of calculating a display position of the pointer based on the input information;

a step 2 of displaying the pointer at the display position calculated in the step 1; and

a step 3 of determining whether there is an object in the front side of the depth position of the pointer based on the display position of the pointer calculated in the step 1, and transparentizing the object in the front side of the depth position of the pointer and displaying the object.

30

39. The three-dimensional display control method as claimed in claim 38, wherein, in step 3, only an object, of objects located in the front side of the depth position of the pointer, that overlaps

35

with the pointer is transparentized and displayed.

5

40. The three-dimensional display control method as claimed in claim 38 or 39, the step 3 comprising:

transparentizing and displaying an object  
10 of the objects located in the front side of the depth position of the pointer, from which objects that are specified or selected based on predetermined input information received from the input apparatus are excluded.

15

41. The three-dimensional display control method as claimed in claim 39, the step 3 comprising:

changing transparency of an object  
according to depth direction distance between the object located in the front side of the depth  
25 position of the pointer and the pointer so as to increase the transparency as the depth direction distance between the object and the pointer becomes larger.

30

42. The three-dimensional display control method as claimed in claim 39, the step 3 comprising:

transparentizing only a region within a predetermined shape having a center point, on the

object, that overlaps with a point at which the  
pointer point, and displaying the object

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43. The three-dimensional display control  
method as claimed in claim 42, wherein the  
predetermined shape to be transparentized changes  
10 according to the depth direction distance between  
the pointer and the object, such that the larger the  
depth direction distance is, the larger the  
predetermined shape.

15

44. The three-dimensional display control  
method as claimed in claim 38 or 39, the step 3  
20 comprising:

a step of, when the pointer stands still  
for a predetermined time, restoring the  
transparentized object to the opaque state that is a  
state before being transparentized, and displaying  
25 the object.

30 45. A three-dimensional display control  
apparatus for controlling display states of a  
pointer and one or more objects, when displaying the  
pointer and one or more objects in a three-  
dimensional space represented on a display apparatus  
35 that can represented the three-dimensional space,  
moving the pointer three-dimensionally based on  
input information from an input apparatus, and

pointing an arbitrary point in the three-dimensional space, comprising:

input information obtaining means for  
obtaining input information from the input  
5 apparatus;

pointer position calculation means for  
calculating a display position of the pointer based  
on the input information obtained by the input  
information obtaining means;

10 pointer generation means for generating a  
pointer to be displayed at the display position  
calculated by the pointer position calculation  
means;

object change determination means for  
15 determining whether there is an object in the front  
side of the depth position of the pointer based on  
the display position of the pointer calculated by  
the pointer position calculation means, and  
determining whether to transparentize the object in  
20 the front side of the depth position of the pointer;

object generation/transparentizing means  
for generating the object to be displayed on the  
display apparatus and transparentizing the object  
that is determined to be transparentized by the  
25 object change determination means; and

display control means for causing the  
display apparatus to display the pointer generated  
by the pointer generation means or the object  
transparentized by the object  
30 generation/transparentizing means.

35 46. The three-dimensional display control  
apparatus as claimed in claim 45, the object change  
determination means comprising:

means for determining whether there is an object, of the objects located in the front side of the depth position of the pointer, that is specified or selected based on predetermined input information  
5 from the input apparatus, and

wherein the object change determination means causes the object generation/transparentizing means to transparentize objects from which the specified object is excluded.  
10

47. The three-dimensional display control apparatus as claimed in claim 45 or 46, the object generation/transparentizing means comprising:

means for calculating depth direction distance between the pointer and the object to be transparentized, and  
20

wherein the object generation/transparentizing means changes the transparency of the object to be transparentized according to the depth direction distance.  
25

48. The three-dimensional display control apparatus as claimed in claim 45 or 46, the object generation/transparentizing means comprising:

means for calculating a point that overlaps with a point, on the object to be transparentized, at which the pointer points, and

wherein the object generation/transparentizing means transparentizes only a region within a predetermined shape having the calculated point as a center.  
35

5                   49. The three-dimensional display control  
apparatus as claimed in claim 45 or 46, the object  
change determination means comprising:  
                    means for determining whether the pointer  
stands still for a predetermined time, and  
10                   wherein, when the pointer stands still for  
the predetermined time, the object change  
determination means causes the object  
generation/transparentizing means to restore the  
transparentized object to the opaque state before  
15 being transparentized.

20                   50. A three-dimensional pointing program  
for causing a computer to execute processes in each  
means of the three-dimensional display control  
apparatus as claimed in any one of claims 45-49.

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